6. DOE Nonproliferation Programs

DOE nonproliferation programs related to countering proliferation are described in this section. These efforts include its new Chemical and Biological Nonproliferation Program and key proliferation prevention activities to limit the spread of nuclear weapons, materials, technologies, and expertise. Key accomplishments since last year's report are also summarized.

6.1 Introduction: Relevant ACEs and DOE Policy Objectives

DOE strongly supports the counterproliferation missions of DoD and U.S. Intelligence primarily through its nuclear proliferation prevention activities. DOE plays a critical role, through its core nuclear work, in addressing ACE priorities in the detection, tracking, and protection of NBC weapon-related materials and components (DOE ACE priority 1); defending against and responding to paramilitary, covert delivery, and terrorist NBC threats through its Nuclear Emergency Search Team (DOE ACE priorities 2 and 4); by supporting inspection and monitoring activities of arms control agreements and regimes (DOE ACE priority 5); and by supporting U.S. Government export control activities (DOE ACE priority 9). In addition to its core nuclear nonproliferation activities, DOE began its Chemical and Biological Nonproliferation Program in 1997 which supports the detection, identification, and characterization of BW agents (DOE ACE priority 3). Building on its experience from its extensive "work for others" program, DOE is working closely with DoD and U.S. Intelligence to detect, characterize, and defeat NBC/M and underground facilities (DOE ACE priorities 6 and 8) and to detect and characterize worldwide nuclear proliferation (DOE ACE priority 7). DOE is requesting $489.4 million in FY 1998, compared to $411.45 million in FY 1997, for nonproliferation and proliferation prevention programs (a 19% increase). DOE's budget breakdown for FY 1998 is provided in Appendix D.

To reduce the international proliferation threat, DOE focuses its resources and expertise on the following near term priorities:

- Detecting and characterizing worldwide production of nuclear materials and weapons;
- Monitoring worldwide nuclear testing;
- Preventing and detecting the diversion or smuggling of nuclear materials;
- Securing nuclear materials, technology, and expertise in Russia and the FSU states;
- Preparing for, detecting, and responding to events involving chemical and biological agents;
- Limiting weapons-usable fissile materials worldwide;
- Ensuring transparent and irreversible reductions of global nuclear stockpiles;
- Controlling nuclear exports;
- Strengthening the nuclear nonproliferation regime; and

- Maintaining and continuously improving a program for nuclear emergency and nuclear terrorism response.

Key Accomplishments. Over the past year, DOE has achieved major successes in a number of areas. The Department played a pivotal role in achieving an indefinite extension of the Nuclear Nonproliferation Treaty (NPT) and in bringing about the signature of the CTBT. It provided leadership for National Laboratory activities aimed at assisting Russia and states of the FSU in critical areas such as export controls, nuclear materials control and accounting, and physical protection. To date, tens of tons of nuclear materials have been secured at over 40 facilities in Russia and seven other FSU states. During FY 1997 and FY 1998, the intense activity experienced during the past 24 months will continue as nuclear material security upgrades continue at the 17 facilities added during the past six months and as additional facilities are added under cooperation with the Russian Navy and icebreaker fleets, the transportation sector, and other locations and activities in the FSU. These successes reflect expanded cooperation at all locations in Russia, the FSU, and the Baltics where weapons-usable nuclear material is located. Further, DOE is committed to cooperating with these countries to ensure that proper export controls on nuclear-related materials, equipment, and technologies are enforced. The Department also anticipates completing the canning of spent nuclear reactor fuel canisters in North Korea and continuing to provide support for International Atomic Energy Agency (IAEA) inspections in both North Korea and Iraq, which reflect the Administration's commitment to reduce the global danger of nuclear weapons proliferation.

DOE also undertakes various activities, as a member of the intelligence community, related to nuclear proliferation intelligence data analysis and treaty monitoring. DOE nonproliferation and proliferation prevention activities are discussed in this section. Joint DOE/U.S. Intelligence activities are discussed in the Intelligence Annex to this report.

6.2 New DOE Initiative: The Chemical and Biological Nonproliferation Program

In FY 1997, directly in response to a CPRC recommendation to establish a joint DOE, DoD, and U.S. Intelligence R&D initiative in chemical and biological defense, DOE began its Chemical and Biological Nonproliferation Program (CBNP). Funding to initiate the program was provided in the Nunn-Lugar-Domenici amendment to the FY 1997 NDAA. The CBNP is focused on leveraging technology developed in the nuclear nonproliferation program and in numerous "work for others" projects to support CW/BW defense and counterproliferation efforts. Both DoD and U.S. Intelligence have long drawn upon DOE National Laboratory capabilities in a broad range of areas through the "work for others" process (through which other organizations can tap DOE National Laboratory capabilities). Such activities are focused on critical near-term defense requirements. Furthermore, DOE has maintained long standing and preeminent R&D programs in the basic chemical sciences, life sciences, and biotechnology in support of both traditional DOE missions (such as nuclear weapons production, production cleanup and environmental remediation, and occupational health and safety) and its Human Genome Project.

The CBNP is coordinating the application of technology developments arising from these efforts to meet various CW/BW defense and counterproliferation needs identified by users from across the interagency community. The CBNP is focusing its activities in four thrust areas: fundamental biology, prediction, detection, and mitigation. The fundamental biology area includes the genomic sequencing of priority pathogens, understanding structure/function relationships for biotoxins, and the development of tools for epidemiological monitoring. In the area of prediction, the CBNP is focusing on the development of atmospheric transport models for use in complex urban terrain (including the interior of structures). CW/BW detection activities center on the development of DNA-based technologies for bacterial agent detection and microseparation technologies for biotoxins and CW agents. The mitigation effort is concentrating on developing rapidly deployable, environmentally benign CW/BW decontamination technologies. DOE has budgeted $17 million in FY 1997 and is requesting $19 million in FY 1998 for the CBNP.

DoD and, to a lesser extent, other government agencies are sponsoring approximately $30 million in CW/BW detection technology development at the National Laboratories. This work is primarily focused on expanding sensor capabilities, finding near-term solutions to the demilitarization of CW munitions stockpiles, and enhancing strategic and tactical intelligence collection and battlefield surveillance. Nonproliferation technology development undertaken by DOE for its nuclear mission, but which at the scientific level is also directly applicable to CW/BW counterproliferation, amounts to approximately $70 million out of the $200 million nuclear verification and control technology R&D program. The National Laboratories annually conduct over $320 million in biotechnology research under the auspices and coordination of the DOE Biotechnology Interlaboratory Council. Chemical sciences research activities exceed this amount, involving such activities as studies of toxicological effects, development of new and miniaturized chemical and biological sensors, remote measurement and sensing of chemical and biological species, development of chemical and biological remediation techniques, and development of advanced chemical and biological laboratory analytical methods. The CBNP program is, therefore, well positioned to leverage this extensive technology base.

6.3 Status and Accomplishments of DOE Proliferation Prevention Programs

6.3.1 Detecting and Characterizing Worldwide Production of Nuclear Materials and Weapons. DOE, in support of DOE ACE priority 1, continued development of both remote and on-site complementary tools to detect and characterize foreign nuclear materials production activities. Acquisition of special nuclear materials is the most important step for a potential nuclear weapons proliferator to accomplish. The ability to detect production is, therefore, a critical proliferation prevention capability, and the ability to detect such production remotely is a powerful deterrent to proliferation. The CALIOPE (Chemical Analysis by Laser Interrogation Of Proliferation Effluents) program is a major remote sensing effort focused on providing such a capability. The CALIOPE program is composed of a multi-laboratory team with the goal of perfecting laser based remote sensing techniques for trace chemical effluent detection. The CALIOPE system will eventually consist of an airborne sensor system for the detection of chemical species in environments indicative of nuclear materials production. A key accomplishment during the past year was the fielding of a ground-based second generation carbon dioxide Differential

Absorption Lidar (CO_2 DIAL) system at the Nevada Test Site. In blind tests, this system demonstrated a significantly improved ability to detect and identify effluents which were released both individually and in mixtures. A second highlight was the execution of a DoD/DOE collaborative airborne CO_2 DIAL experiment called the Nonproliferation - Airborne Lidar Experiment (N-ABLE). N-ABLE demonstrated the ability to detect and identify sub-lethal concentrations of CW agents at extended standoff distances.

Other nuclear weapons clandestine production detection efforts are focused on the development of a small satellite demonstration system employing multispectral infrared imaging techniques. These imaging techniques are useful to detect and monitor such production indicators as reactor cooling pond temperatures, which can be used to estimate plutonium production rates. The system is scheduled for launch in FY 1999. Multispectral change detection also can be useful in detecting undeclared production related facilities and activities. Over the past year, substantial progress was made on an end-to-end modeling system that will aid in extracting facility power estimates from thermal signatures and on the assembly of a high precision thermal imager calibration facility. These efforts exploit a unique combination of DOE National Laboratory expertise in the nuclear weapons production cycle, production signatures, laser systems, rapid prototyping, and satellite systems engineering. Planned funding for production detection activities in FY 1998 is $66.8 million compared to $69.7 million in FY 1997.

6.3.2 Monitoring Worldwide Nuclear Testing. DOE, in support of DOE ACE priority 5, continued to develop and deploy elements of U.S. capabilities for monitoring the Limited Test Ban Treaty (LTBT) and the CTBT. DOE has a long standing partnership with DoD in this area, with DOE designing and producing nuclear detonation detection sensor systems for deployment on DoD Global Positioning System (GPS) and Defense Support Program (DSP) satellites (see subsection 5.2.4). These systems include optical, x-ray, gamma-ray, neutron, and electromagnetic pulse (EMP) sensors. During the past year DOE delivered four GPS payloads, upgraded GPS x-ray and optical instruments to extend their operating ranges to partially overlap with the CTBT regime requirements, and supported the launch of one DSP payload. Additional satellite-based, CTBT related activities included preparations for launch of a prototype satellite (denoted "FORTÉ") in the summer of 1997 to demonstrate an autonomously triggered, non-deniable, all-weather EMP sensor system, and the mapping of EMP backgrounds recorded by the ALEXIS satellite.

Ground-based technical methods associated with the CTBT, and specifically intended for the International Monitoring System (IMS), involve hydroacoustics, seismology, radionuclide detection and characterization, and infrasound techniques. DOE is actively pursuing specification of the IMS, and has supported U.S. Government efforts to obtain international agreement on a 60 station infrasound network and a 118 station seismic network. One focus of the seismic studies is to characterize regional areas of interest to improve the detection of smaller and potentially evasive tests. During the past year, a database of germane signals in China was assembled, including those from earthquakes, nuclear events, and high explosive events. Data analysis as well as algorithm and automated data processing development continue and draw upon National Laboratory experience in nuclear testing, mining and seismic geology, field measurements, and data fusion.

DOE completed design of a prototype infrasound station for eventual commercial production and possible inclusion in the IMS and expects to complete a prototype later this year. DOE National Laboratory experience in atmospheric science is especially relevant to this activity. Hydroacoustic monitoring provides yet another complementary tool to detect low yield, potentially evasive testing. DOE is also developing the specifications for an ocean monitoring system. Intermediate accomplishments include signature assessments of evasive explosions and the development of detection system specifications. Radionuclide techniques offer another important tool by providing critical forensic data to support CTBT verification. DOE is developing radionuclide particulate as well as prototype xenon gas samplers for commercialization and use by the IMS. DOE works closely with DoD to support CTBT verification activities. Planned funding for nuclear test monitoring activities in FY 1998 is $81.2 million, unchanged from FY 1997.

6.3.3 Preventing and Detecting the Diversion and Smuggling of Nuclear Materials. DOE's efforts to prevent and detect nuclear smuggling (DOE ACE priorities 1 and 7) are focused on securing nuclear material at its source, detecting stolen material in transit, responding to threatened and actual events, and determining the origin of intercepted material. Extensive DOE efforts are focused on protecting domestic nuclear materials and combating smuggling by securing potential sources of material in the U.S. Similar efforts in protecting nuclear materials worldwide are described in the next several sections. To deal with materials in transit, DOE works closely with DoD, U.S. Intelligence, and others in the interagency community providing technology support for detection and interdiction of stolen nuclear materials. In addition, DOE and National Laboratory personnel lead an international technical working group to help determine the sources of smuggled nuclear material by applying the full scope of laboratory forensic methods on intercepted materials. This program exploits multiple DOE expertise in environmental and nuclear material production signatures, radiochemical analysis, and law enforcement support. Planned funding for these activities in FY 1998 is $43.5 million, up from $31.0 million in FY 1997.

6.3.4 Securing Nuclear Materials, Technology, and Expertise in Russia and the FSU. Two DOE programs comprise this activity: the Material Protection, Control and Accounting (MPC&A) program and the Initiative for Proliferation Prevention (IPP). The MPC&A program is primarily related to nuclear materials security and nonproliferation, and the goal of the IPP is to engage scientists and engineers from the weapons institutes of the FSU in peaceful technology applications in order to help stabilize personnel and resources that represent a potential risk of "expertise proliferation". Total funding requested for FY 1998 is $167.0 million compared with $142.6 million received for FY 1997 (which reflects a congressional plus-up of $33.2 million).

The MPC&A Program. Material protection, control, and accounting cooperative upgrade programs are now under way at over 40 locations in Russia and seven other FSU states, representing more than 75% of the known locations possessing weapons-useable nuclear materials. To date, DOE has improved the security of tens of tons of weapons-useable nuclear materials, and negotiations are currently under way (scheduled to be completed this year) to expand MPC&A cooperation to include all weapons-useable nuclear material at all known facilities in the FSU. Sites not yet covered by the MPC&A program include four Russian Ministry of Atomic Energy (Minatom) nuclear weapons production and dismantlement facilities, a handful of sites that possess highly enriched uranium (HEU) fuel for naval nuclear propulsion, and a few small research

facilities. The MPC&A program does not address nuclear materials in assembled weapons; these will be covered in other cooperative programs between DoD and the Russian Ministry of Defense. Expanded cooperation in 1997 includes accelerated work with the Russian Navy, continued cooperative efforts at Minatom facilities, and the addition of security enhancements for nuclear material transport. FY 1998 efforts will include: i) increased equipment procurement; ii) funding additional work in Russia and Kazakstan and accelerating ongoing work throughout the Minatom defense complex; iii) extending naval fuel work to cover the icebreaker fleet, naval support ships, and naval nuclear fuel transportation; iv) fully implementing efforts to improve the MPC&A for nuclear materials during transportation; and v) continued expanded cooperation with the Russian Federal Nuclear Radiation and Safety Authority (denoted by its Russian acronym "GAN"), including start-up of a pilot Russian federal MPC&A information system. Additional efforts to help improve the safeguards culture will be supported through development of nuclear regulations and training of GAN inspectors. Because of the size and complexity of some of the sites, full implementation of MPC&A safeguards is expected to take several years to complete, extending through the year 2002.

DOE is also working with governments and institutions of the FSU countries to strengthen their export control systems and, thereby, stem the illicit flow of nuclear materials, equipment, and technology. Much of this effort is accomplished at the grass-roots level through laboratory-to-laboratory cooperative programs in export control. The objective is to engage their scientific community in their own national export control systems, just as the expertise of the DOE National Laboratories serves the U.S. Government. DOE is also identifying and training technical experts in the FSU in how government agencies can administer export controls. DOE laboratories explain how to provide expert technical advice to the agencies, how to review export license applications, and what to be alert for in the export control arena.

The Initiative for Proliferation Prevention. As previously noted, the primary objective of the IPP is to stabilize personnel associated with NBC weapon programs within the FSU to minimize the risk of the proliferation of NBC weapons expertise. The IPP program draws scientists, engineers, and technicians from FSU NBC weapons programs into commercial ventures, avoiding potential "brain drain" to would-be proliferants and providing long term employment in non-weapons work. Under the IPP, DOE National Laboratories work with Russian and FSU institutes to identify and evaluate the commercial potential of various products related to R&D activities conducted at those institutes. Cooperative projects between a coalition of 75 U.S. laboratories, corporations, universities, and the nuclear inheritor states of the FSU have engaged more than 2,700 former weapons personnel in the FSU in projects ranging from MPC&A and nuclear safety to materials science, biotechnology, and instrumentation.

6.3.5 Limiting Weapons-Usable Fissile Materials Worldwide. Activities in this area focus on eliminating or reducing stockpiles of plutonium, promoting alternatives to the civilian use of plutonium, and reducing stockpiles of plutonium and HEU, as well as eliminating the civilian use of HEU. Further, DOE will be supporting U.S. Government efforts to negotiate an international convention to end the production of fissile material for weapons purposes. Following judicial review of objections to the return of foreign research reactor spent fuel, the U.S. has begun accepting shipments of U.S.-origin enriched nuclear materials from overseas. New funding in FY

1998 will support the development of advanced high density low enriched uranium fuels for Russian and Chinese reactors and for the remaining unconverted reactors in Western Europe and the U.S. DOE expects to begin work to convert the plutonium production reactor in Russia to energy-only production. Funding requested for this activity in FY 1998 is $16.4 million, compared to $16.6 million in FY 1997.

6.3.6 Ensuring Transparent and Irreversible Nuclear Reductions Worldwide. Activities focus on: i) the exchange and confirmation of data on nuclear weapons materials inventories; ii) monitoring nuclear warhead production and expediting dismantlement of excess weapons under bilateral agreements; iii) conducting reciprocal bilateral inspections of nuclear components and materials; and iv) implementing the purchase agreement of 500 metric tons of HEU from dismantled FSU warheads while working to reduce weapons inventories. FY 1998 will see continued: i) technical expert support and conclusion of negotiations for Russian HEU Purchase Agreement transparency measures; ii) technical analysis relevant to plutonium Mutual Reciprocal Inspections (MRI); iii) negotiations with the Russians on plutonium MRI; and iv) technical and analytical support from the DOE laboratories to establish transparent and irreversible nuclear reductions. Funding requested for this activity in FY 1998 is $3.5 million, compared to $4.0 million in FY 1997.

6.3.7 Controlling Nuclear Exports. Activities in this area assist the international community in: i) effectively controlling exports and establishing responsible supplier policies; ii) implementing U.S. statutory licensing requirements for nuclear or nuclear-related export controls; iii) encouraging adherence to the Nuclear Suppliers Guidelines; and iv) strengthening multilateral supplier initiatives, including enhancing export controls in the FSU states. FY 1998 efforts will assist FSU states in controlling exports, reforming statutory licensing requirements, strengthening multilateral supplier initiatives, and promoting expanded information sharing and analysis. Funding requested for this activity in FY 1998 is $16.5 million, down slightly from $16.9 million in FY 1997.

6.3.8 Strengthening the Nuclear Nonproliferation Regime. FY 1996 and FY 1997 efforts promoted adherence to the NPT and increased the effectiveness and efficiency of the IAEA. DOE also provides technical expertise to enhance IAEA capabilities to detect undeclared nuclear activities. Successes included the negotiation and signing of the CTBT and facilitation of IAEA inspections of excess fissile materials. Other activities actively promoted regional nonproliferation measures. FY 1998 will see the negotiation and implementation of agreements for safeguards cooperation for improved material protection, control, accounting, and transparency with other countries and international organizations including China, Japan, South Africa, South Korea, the IAEA, European Atomic Energy Community, Argentina, Brazil, the Argentine-Brazil Accounting and Control Commission, and Australia. Funding requested for this activity in FY 1998 is $34.4 million, down from $39.3 million in FY 1997.

6.3.9 Nuclear Emergency and Terrorism Response. DOE maintains several emergency response assets postured to respond to events that may occur should proliferation prevention efforts fail. DOE conducts analyses and provides operational and technical support in response to nuclear emergency and terrorism events worldwide. This includes the Nuclear Emergency Search

Team (NEST) which has primary responsibility for responding to acts of nuclear terrorism or other incidents involving nuclear weapons or devices. It can be deployed under the authority of the FBI for domestic incidents and the Department of State for foreign incidents. Requested funding for DOE emergency management and response programs in FY 1998 is $41.1 million up from $35.3 million in FY 1997. Additional details are provided in Section 8.4.

6.4 DOE Technologies Developed to IOC

Except for the specific portions of the satellite nuclear detonation detection activities for nuclear test monitoring, DOE-developed technologies are not normally taken to initial operating capability (IOC). Under DOE technology development activities, the end product is a capability demonstration of a system or method, most commonly in the form of a field capable prototype, developed in direct response to requirements identified by a user agency (e.g., DoD or U.S. Intelligence). It is at this stage in the hardware development cycle that DOE program managers encourage and participate in the transfer of the technology product to the user community for field hardening, engineering refinements, and production.

DOE currently produces satellite-borne sensors for the national capability to monitor and verify compliance with the LTBT and the CTBT. These sensors are secondary payloads on the GPS and DSP satellites (as described above in subsection 6.3.2). DOE is developing the next generation of improved optical, x-ray, and space environmental sensors to provide a better capability to monitor the continuation of the LTBT and to enable the U.S. to monitor and verify the CTBT after entry-into-force. The sensor systems under development are planned to go from development, through IOC, to production to meet required delivery dates for the next generation of GPS satellites. In addition to these satellite systems, DOE is also developing ground based components for airborne radionuclide sampling systems and will be heavily involved in supporting DoD and other agencies of the U.S. Government in identifying reliable commercial suppliers.